



fluid pump for medicinal applications and
measuring chamber therefor

The invention relates to a fluid pump according to the introductory part of Claim 1 and a measuring chamber according to Claim 7.

Patent specification DE 195 25 926 C1 discloses a peristaltic pump system in which a measuring device is inserted into the pump system hose line after the pump. This measuring device downstream of the pump determines the fluid transport volume of the pump by pressure measurement. In this case the measuring device is built up in simple manner as a block so that it can be removed from a mounting in order that the test housing can be disinfected without complication. At the same time the fluid pressure is transmitted from the interior of the test housing to the outside via openings which are covered tightly by a membrane.

In so doing the test housings can be built up of reusable measuring chambers to be disinfected or alternatively of single-use products packed in sterile manner. Due, however, to the removability of the measuring chamber or the design of the measuring chamber as a separate, exchangeable accessory part the critical and serious disadvantage, especially in the field of medicine, arises that a measuring chamber which is actually destined and suitable for a certain first pump system is inadvertently employed in a different pump system as a result of which the proper functioning of the latter pump system is put in question.

This is especially the case, for example, when pump systems with their respective measuring chambers are on hand from different manufacturers as accessories and the measuring

chambers from a first manufacturer can be inserted into the pump systems of a different manufacturer (in particular in this case when the external dimensions of the measuring chambers from the different manufacturers are identical to one another) but properties of the measuring chambers of importance for the pressure measurement differ from manufacturer to manufacturer. This can cause faulty operation of the pump systems.

Accordingly, it is the object of the present invention to specify a fluid pump having a pressure measuring chamber and a pressure measuring chamber therefor which is particularly simple and robust to handle in clinical practice, for which the measuring chambers are particularly inexpensive to manufacture in industrial mass production and wherein the inadvertent use of a measuring chamber in a pump unsuitable for this measuring chamber is prevented.

These tasks are solved according to the invention by a fluid pump according to Claim 1 and a measuring chamber according to Claim 16.

The invention according to Claim 1 exhibits the following advantageous characteristics.

Due to the fact that code value carrier means are provided on the measuring chamber of the fluid pump according to the invention the particular advantage is achieved that code values can be entered into these code value carrier means and hence the measuring chamber can be individualised. Such code values can be alphanumeric values or other values which carry information about type and/or performance characteristics of the measuring chamber or its manufacturer. Due to the fact that during and/or after fixing on the pump housing of the fluid pump - for example by insertion into a holding device in the

fluid pump - the code value carrier means can be recorded by the read-out means of the fluid pump a particularly impractical additional work step in the practical clinical field is avoided from the outset, for example establishing an electric cable connection between the code value carrier means and the fluid pump or for instance the manual read-out of a scanning code applied to the housing of the measuring chamber by a manual scanner connected to the fluid pump.

Due to the fact that read-out means are provided which can read out the code value from the code value carrier means the fluid pump can match its operational behaviour in operation to the measuring chamber employed according to the code value entered into the code value carrier means on the measuring chamber. This matching can consist, for example, in a change in the transport behaviour of the pump or the pump denying its operation for transport.

The ability to fix the pressure measuring chamber on the pump housing can be achieved for instance in that the housing of the measuring chamber and the fluid pump are equipped in such a way that the measuring chamber is insertable into a holding device on the fluid pump. Thus, it is particularly easy to fit it into a tube line without additional fastening effort and to remove it again without appreciably increasing the length of the tube line in doing so. Such a housing design can be achieved for instance in that the box-shaped housing has a smooth and robust surface which is scratch-proof and resistant to fracture and in which fragile outer parts are dispensed with.

Advantageous refinements of the invention according to Claim 1 are possible according to the subsidiary claims referring back to the latter and are explained below.

The adaptation of the pump behaviour is brought about by the functions of the control means of the fluid pump which control the behaviour of the fluid pump as a function of the code value recorded by the read-out means and held in the code value carrier means of the measuring chamber. In this way it is made possible when using different measuring chambers having at least externally identical geometric dimensions to control the operating behaviour of the pump by using different code values: for instance in that a first measuring chamber having a first code value triggers the transport properties of the pump for interventions in the field of the central nervous system and alternatively a second measuring chamber having a second code value in the same fluid pump triggers the transport properties for endoscopic interventions in the knee.

In this way it can also be effectively prevented that erroneous use of a measuring chamber not belonging to the pump results, for example, in the pressure of the transported fluid and hence its transport flow rate being wrongly determined or a measuring chamber being used in association with the fluid pump which does not meet the properties demanded and specified by the pump manufacturer.

A particularly simple implementation of the interplay of the code value carrier means and read-out means is to implement the code value carrier means as one or more, for example pin-shaped, profiles on the measuring chamber housing which due to a suitably complementary profile in the pump housing allow complete fixing of the measuring chamber on the pump housing only when the pattern (corresponding to the code value) formed by the pins matches that specified by the profiling of the pump housing. The fluid pump can then be implemented in such a way that it assumes its transport operation only when a measuring chamber is completely fixed on it.

Other methods of implementing the control means, especially when they are realised by functions suitable for the purpose of electronic control means, are based on the principle that from the code value carrier means a code value contained therein is detected by the read-out means and checked by means of a suitable control logic circuit to see whether this code value (or this number of code values) agrees with the code value(s) expected by the control logic circuit of the fluid pump and/or held therein and thereupon by simple insertion of a measuring chamber coded in suitable manner the transport behaviour of the fluid pump is adapted according to the desired medicinal use or blockage of the pump is triggered so that safe operation of the pump can be ensured.

A particularly advantageous method of implementation is when the code value carrier means contain means for optical and/or electric and/or magnetic and/or mechanical code value storage and also means for transmitting a code value in one of the aforesaid ways insofar as these cannot be read out directly from the code value carrier means by the read-out means of the fluid pump.

In doing so the read-out means need not necessarily embody the same principle of implementation as the code value carrier means but be adapted to these. Thus, it is conceivable for instance to have mechanical code value storage by means of prominences on the housing which are detected optically or alternatively mechanical scanning of a magnetic storage system.

It is particularly advantageous for the code value contained in the code value carrier means - a plurality of code values simultaneously is equally conceivable - represent information relating to the technical properties of the measuring chamber

(such as flow cross-section of the transported fluid or cross-section of the measuring nozzle) and/or relating to the manufacturer (measuring chamber manufacturer or fluid pump manufacturer) and/or relating to the intended mode of operation of the pump (desired transport volume, permitted transport tolerance in different medicinal applications).

A practical and particularly low-cost variant for implementing the coding means is, for instance, to provide on the housing of the measuring chamber mechanically scanable prominences and/or depressions and/or excavations. By this means a low-cost and robust solution for the code value carrier means is selected whose serviceability is not impaired by moisture and/or chemicals, radiation and heat. If these code value carrier means are arranged on one side of the measuring chamber housing so that they come into direct contact with the read-out means of the fluid pump the scanning of the code pins can take place by means of electric pressure contacts, as in a pressure-sensitive keyboard for instance. Particularly advantageous is to arrange the code value carrier means and read-out means in such a way that they are placed in effective contact with one another directly by fixing the measuring chamber on or in the housing of the fluid pump without further action.

Other methods of implementation are also conceivable, however: the use of a barcode for instance as the code value carrier means and a barcode reader as the read-out means of the fluid pump as well as representation of the code value in the code value carrier means by colours. In these two forms of coding it is advantageous that the barcode or the colours as an implementation of the code value carrier means afford a very low-cost method of implementation on the part of the measuring chamber which is important because the measuring chambers in

comparison with the fluid pumps are produced in very large numbers.

A somewhat more costly method of implementation provides for an integrated circuit as the code value carrier means in which circuit at least one code value is stored. In doing this it is advantageous that the number of code values or the information contained in the code value can be much more extensive. In connection with this a particularly advantageous method of implementation is to transmit the code value from the code value carrier means to the read-out means by electromagnetic signals.

Particularly with regard to the practical clinical use of the measuring chambers it is particularly advantageous to provide the housing of the measuring chamber with means for the unique identification of the orientation of the housing relative to the fluid pump housing. When fixing the measuring chamber on or in the pump, eg in a holding device provided for this purpose on or in the pump and by a translational movement of the measuring chamber in the longitudinal direction of the measuring chamber housing, this is a simple way of preventing it being inserted the wrong way round, in particular with the chamber connected counter to the planned direction of flow in the tubing circuit. By providing such means the user need not take any particular care when inserting the chamber. For example, they can take the form of a special shape for the housing in association with a complementary shape on the fluid pump such as, for instance, the use of asymmetric geometric properties in housing geometries.

A further advantageous refinement of the measuring chamber provides for a membrane on the measuring chamber onto which the pressure from the interior of the measuring chamber can be

transmitted through openings provided for this purpose in the measuring chamber housing, wherein the openings are tightly covered by the membrane so that due to the leak-proofness of the covering of the openings by the membrane the transported fluid remains in a closed system in the region of the measuring chamber.

In combination with the membrane and in particular with regard to practical use it is advantageous to equip the measuring chamber additionally with a membrane protector completely covering the membrane by which means the membrane is reliably protected on the measuring chamber in practical use such as transport or disinfection and unintended tearing or bulging of the membrane is prevented. In doing this it is particularly advantageous for the membrane protector to be opened by lateral displacement along the measuring chamber housing.

For example, this can be constructed in such a way that on fixing on the fluid pump the membrane protector is automatically caused to expose the membrane and hence allow the fluid pump contact with the membrane, for fluid sensors in the fluid pump for instance. By this means in particular the disadvantage of a sheath-like or hood-like cover is avoided which must be put in position or removed with some effort by hand and which in particular can easily be lost. In a manner analogous to the automatic opening of the membrane protector on fixing the membrane protector can be closed on removal of the measuring chamber out of or from the fluid pump.

A particularly practicable embodiment for the lateral displaceability of the membrane protector constructed as a plate takes the form of guide rails along the measuring chamber housing which can be implemented as mouldings on the measuring chamber housing.

By means of the automatic opening and closing of the membrane protector on the measuring chamber when it is fixed on or in the fluid pump there is no need for unwieldy manual pushing aside or removal of the membrane protector - or putting it back on - which might require the user to use both hands.

Another advantageous embodiment of the measuring chamber provides for locking means on the measuring chamber which hold the housing by friction fitting and/or form fitting after it is fixed on a fluid pump. The means of engagement as preferably constructed in such a way that on fixing they produce a clearly perceptible click and fixing and removal can be effected by simple and direct application of translational force, in particular without operation of additional unlocking devices.

It is, furthermore, advantageous to provide a pump segment which is fixedly connected by clamping to the measuring chamber on the inlet side. This has the advantage that on each change of measuring chamber this pump segment is also exchanged. This is of particular importance when the drive of the fluid pump constructed as a peristaltic pump is implemented via a roller wheel and for that reason on the pump segment constructed as a flexible tube particularly high demands are imposed on the mechanical properties of the pump segment. These mechanical properties are subject, however, to particularly marked ageing or attrition during use so that regular replacement must be ensured. In the present embodiment this is ensured by the fixed attachment to the measuring chamber.

Another advantageous embodiment provides for a flow channel in the measuring chamber and the construction therein of a measuring nozzle reducing the flow cross-section of the fluid streaming through the flow channel, wherein ahead of and

following the measuring nozzle openings are arranged for externalising the measuring chamber which allow measurement of the pressure.

The characteristics of the invention exhibit the following advantageous effects.

Due to the fact that the measuring chamber contains code value carrier means in which at least one code value is present and which contain means for code value storage and transmission it is achieved that due to the code value contained it is achieved in simple manner that the measuring chamber can be individualised and the compatibility of measuring chambers with fluid pumps from different manufacturers can be selectively controlled as described above in more detail in the statements about the advantageous effects of the fluid pump according to Claim 1. Compatibility and individualisation can be provided in this manner without the need for producing differences in the housing or in the mechanically fitted shape which are costly in production terms. By this means the effects of scale in large-scale industrial production are exploited since housing production for all measuring chambers can ensue in the same way according to external dimensions and in this way rationalisation effects in production arise.

Advantageous refinement of the invention according to Claim 7 is possible according to the subsidiary claims referring back to the latter and correspondingly to the refinements of the fluid pump relating to the measuring chambers.

The invention is explained below with reference to an exemplified embodiment. The drawings show:

Fig 1 a wedge-shaped measuring chamber with a membrane in which the membrane protector is in the open and closed state and bearing code value carrier means in the form of code pins;

Fig 2 a cut-away view of the measuring chamber from the side of the housing opposite the membrane, a view at right angles to the membrane side and a view of the membrane side;

Fig 3 a fluid pump constructed in the form of a peristaltic pump having a roller wheel and roller wheel and holding device for accommodating the measuring chamber pushed in from the side;

Fig 4 the fluid pump illustrated in Fig 3 with inserted and locked measuring chamber as illustrated in Figs 1 and 2;

Fig 5 a detailed version of that shown in Fig 1 with guide rails and locking means, wherein in this case the housing shape is a parallelepiped; and

Fig 6 a detailed version of that shown in Fig 4 showing guidance of the pump segment on insertion and on stabilisation of the measuring chamber.

Fig 1 shows an exemplified embodiment of a measuring chamber according to the invention. The measuring chamber has a block-like housing 1 with a level surface. On one end face of the block-like housing 1 a pump segment 5 is clamped in place and inserted into the other end face is a tube connection 6 which each form the extension of a flow channel 7 not illustrated in more detail in this figure. In accordance with the invention and as described later in association with Figs 3 and 4 the

measuring chamber or the housing 1 is pushed into a mounting which at present is not necessarily fastened to a pump.

Likewise on the end face of the housing 1 accommodating the pump segment 5 there are located code value carrier means 4 implemented in the form of code pins. These code pins contain a code value which, for example, contains the name of the company which produced the measuring chamber and the cross-section of the flow channel in codified form. The code pins 4 are located on the side located in the plug-in direction of the measuring chamber in the holding device of the fluid pump provided for this purpose. In this special case, but not generally, the plug-in direction is the side from which the fluid flows into the measuring chamber.

A membrane 2 can also be seen which covers openings 8 and 8' between the flow channel and the outside of the measuring chamber which are not illustrated in more detail in this figure (see Fig 2). A membrane protector 3 is constructed in this case in the form of a plate which is displaceable to the side and is guided in stable and secure manner to prevent it slipping out by guide rails 13 projecting from the housing above and below the membrane protector plate 3. Thus, Fig 1 I shows the membrane protector in the open state and Fig 1 II the measuring chamber with the membrane protector in the closed state. When handling the measuring chamber when it is not inserted in the holding device of a fluid pump the state depicted in Fig 1 II is the normal state. Here a return structure can be provided in the housing 1 which ensures that insofar as a lateral displacement force is not used the membrane protector 3 always returns to the basic state as depicted in II.

Fig 2 shows the same measuring chamber in cut-away from the side (I) located opposite the membrane, in cut-away

perpendicular to the membrane side (II) and from the membrane side (III).

In Fig 2 I the pump segment 5 can be seen in the way it is plugged into the inlet of the flow channel designated by 7. The flow outlet in the form of the tube connector 6 is also clearly visible. I shows how the membrane surface 2, illustrated by the continuous line of the rounded rectangle surrounding the area 2, covers the openings 8 and 8' illustrated as the interior of the dotted rings located therein. Located above this the membrane protector 3 is illustrated by a dotted line. Likewise illustrated by dotted lines are the code pins 4 in one end face of the housing.

The view II turned with respect to I by 90° in the horizontal plane shows the membrane protector 3 in the guide rails 13 provided for this purpose which continue to the side on the right to the outside so that the membrane protector can be pushed to the right beyond the boundary of the measuring chamber housing. In this view the openings 8 and 8' are also clearly visible which connect the inside of the membrane 2 (not illustrated in more detail in this view II) to the flow channel 7.

The view III shows the closed membrane protector 3 as a continuous line and located behind it in dotted lines the membrane 2 and the openings 8 and 8' which lead to the flow channel 7 located inside. It is also shown how the membrane protector is held in the guide rails. Where the continuous line of the membrane protector plate 3 engages behind the likewise continuous projection engaging round the plate 3 at top and bottom the continuous line of the membrane protector 3 passes over into a dotted line.

A measuring nozzle located between the openings 8, 8' in the flow channel is not illustrated in more detail but is readily imaginable, especially in the view II between the openings 8 and 8', as a tapering of the flow channel 7.

Fig 3 shows an exemplified embodiment of a fluid pump according to the invention constructed in the form of a peristaltic pump which in the present case is designed to accommodate the measuring chamber as implemented in the exemplified embodiment in Figs 1 and 2 described above so that the fluid pump and measuring chamber are actively connected according to the invention.

Other forms of fluid pumps of analogous design with regard to the active connection to the measuring chamber may contain a drive based on the peristaltic principle but without a roller wheel for producing the peristaltic effect or, furthermore, a drive based on a rotor or impeller which for its part may be driven by magnetism and may also be arranged in the axial direction relative to the transport channel. A design in the form of a gear-type pump having a closed gear chamber is also conceivable.

In the present exemplified embodiment in the form of a peristaltic pump the housing 15 has a roller wheel 9 around which a flexible tube can be placed and the holding devices 10. Accordingly, the transport channel is constructed as a tube line.

The holding devices 10 are mouldings on the pump housing and formed in such a way that they completely accommodate and in doing so securely encompass the block-like housing 1 of the measuring chamber which is of prismatic construction with a trapezoidal outline on the membrane side. For this purpose the

holding devices 10 have sloping guide surfaces 14 which engage with the sloping side surfaces of the housing.

At the end of the holding devices 10 viewed in the insert direction at least one read-out means constructed as a reading contact 11 is arranged which works together with the code pins 4. The at least single reading contact 11 and the code pins 4 may also have different embodiments, that is to say be implemented in mechanical, eg pins and holes engaging in one another, electrical, optical and/or mechanical manner.

Through mechanical scanning of the corresponding code pin 4 of the measuring chamber the reading contact 11 is able to read out the single-place code value located therein. In this example it is checked whether the measuring chamber to be inserted in the mounting 10 is compatible with the pump.

The housing 15 of the pump is provided with pressure sensors 12, 12' which work together with the measuring chamber. For this purpose the pressure sensors 12 and 12' are arranged in such a way that when the measuring chamber is inserted they are directly in active contact with the membrane 2 exposed from its membrane protector 3 as soon as the measuring chamber is completely pushed in and locked in place, wherein the pressure sensors are located directly opposite the region of the openings 8 and 8' concealed behind the membrane. Locking means, which are not illustrated, are provided for locking the measuring chamber to the holding device 10. These are fitted on the holding device 10 and/or the housing 1 of the measuring chamber.

The presence of only one read-out means 11, ie a mechanical scanner for only one code pin, serves only to improve the clarity of presentation. A plurality of read-out means can of

course be present which can advantageously be arranged (as in the intake of a strip scanner) one above the other in a row as suggested in the illustration of the code pins 4 in Fig 1 I.

Fig 4 shows the fluid pump illustrated in fig 3 with the measuring chamber inserted and locked in position as illustrated in Fig 1 I. At the start of the insertion operation the membrane protector 3 is caught by a catch, which is not illustrated in more detail, at the level of the pressure sensors 12, 12' and held so that the membrane 2 on the measuring chamber is exposed as the insert movement continues. In this condition of being fully inserted and locked in place the reading means 11 make contact with the code value carrier means 4 so that the control means in the system, which may also contain the means for determining the transport volume from the signals of the pressure sensors, determine whether the system is ready for operation and/or in which way the system operates. At the same time the pressure sensors are in active contact via the membrane 2 with the openings 8 and 8'.

If the measuring chamber is equipped with a suitable return device then on unlocking and removing the measuring chamber from the holding device on the fluid pump the membrane protector 3 advances again over the membrane to protect it without any action by the user. From here the measuring chamber can be collected without any special care and be disinfected which proves to be advantageous especially in practical clinical operations.

Fig 5 shows a more detailed version of that shown in Fig 1 with guide rails 13 which grip around the sides of the membrane protector plate 3 covering the membrane 2 and in which recesses are provided at the right-hand end in the drawing into which the correspondingly shaped right-hand ends of the membrane

protector plate 3 engage in friction fitting manner and in this way secure the position of the membrane protector.

Also illustrated again are the code value carrier means 4 constructed as code pins which here take the form of convex, pin-like mouldings on the housing together additionally with the engaging means 20 each located on the top or bottom of the measuring chamber housing which on fixing the measuring chamber on or in the housing of the fluid pump engage with a clearly perceptible click and secure the measuring chamber in friction fitting manner against inadvertent detachment from the fluid pump. Furthermore, in this figure the measuring chamber housing has an elastic attachment 21 which positions the measuring chamber securely inside the mounting after fixing implemented as insertion in a holding device of the fluid pump in that the elastic attachments 21 from one side push the measuring chamber located in the mounting away from one side and against the other side where the sensors are so that no unintended movement of the measuring chamber housing relative to the fluid pump can take place.

Fig 6 shows how fixing of the measuring chamber on a fluid pump implemented in the form of a peristaltic pump can be carried out.

Brought into the position shown the pump segment 5, which in this figure is shown merely as a short length and in reality is many times longer, can be gripped by one hand and at the same time the measuring chamber housing connected to the pump segment 5 is moved into the holding device 10 by pulling in the direction of the roller wheel 9. In the course of this movement the person operating the instrument can guide the pump segment clockwise round the roller wheel into the holding device 15 and finally clamp it in the locking device 16. In this way the pump

segment is fixed in a stable position and the measuring chamber is fitted securely into the holding device. The elastic attachments 21 here ensure that the measuring chamber is pressed against the pressure sensors 12 for the measuring chamber and prevent unintended slippage while the locking means 20 produce a clearly perceptible click on engagement as soon as the measuring chamber reaches the fixed position of operational readiness on the fluid pump and further secure the measuring chamber against unintended slippage out of the holding device 11.

Another characteristic of the measuring chamber illustrated in this figure is that it has a label surface 30 for holding information such as a label bearing the logo of the manufacturer or other information, eg the field of use of the pump, "Only for uteroscopy" for instance.